themselves. The difference in density created by temperature changes creates local recirculating loops which eliminate stream-line flow.

A good idea of these confused currents may be gained by observing any current of hot air rising alongside of a hot furnace. These currents may be rendered visible by using a bright light which will be partially polarized by the eddies created, causing them to cast a shadow. A light which contains an appreciable proportion of the blue end of the spectrum will render visible the heat waves beyond the visible red of the spectrum.

In a gas-to-fluid heat transfer through a metal partition, there are two very important factors, either one of which will limit the value of the test. The heat transmission of the metal will be limited by the manner in which the fluid circulates past the wet surface, to a much greater degree than it will be limited by the manner in which the hot gases circulate past the dry sur-face. Practically all the recent experiments regarding gas-to-fluid heat transfer through metal have entirely neglected the part played by the fluid in carrying off the heat. Until the fact is recognized that the gases cannot transfer heat to the metal any faster than the water, in turning to steam, is able to carry it away from the metal, very little progress will be made in boiler design.

In metallurgical furnace work it has long been recognized that there are limitations upon the rate of temperature drop. In this work there is frequently only a small temperature differential between the gas giving up heat and the material to which heat is imparted. In the steam boiler the temperature differential between the hot gases and the water turning into steam is very large, and the main obstacle to a high rate of heat transfer is the poor arrangement of the water circulation.

Table 20 gives the quantity of heat available for a waste-heat boiler at various initial and final temperatures, together with the drop in temperature, initial and final gas volumes and the change in the gas volume due to the drop in temperature. These values clearly illustrate the large amount of heat lost by the drop in temperature between the regenerator and the boiler and carried away from the boiler by high waste-gas temperatures. With leaky gas flues there is not only the drop in gas temperature, but the added volume of air, which may increase the volumes to be dealt with by 30 to 40 per cent, or more.